Mathematical Model of the Water Quality in Kalibaru Watershed

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Mathematical Model of the Water Quality in Kalibaru Watershed

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Abstract. The Kalibaru Watershed is one of the watersheds which needs to be concerned because it is suspected to have decreased water quality, due to the high activity of the households, industry, livestock, and agriculture. This condition implies that the water quality as the embodiment of the environmental capacity of Kalibaru Watershed needs to be studied, so that it can be known how far it benefits the lives of the society.The aim of the research were to determine the water quality related to physical properties (pH), chemical properties (BOD, PO_4P, NO_2N) and microbiological properties (*Fecal coli*) from observation stations upstream, central and downstream of Kalibaru River watershed. The research approach framework was carried out by: (1) data collection to describe water quality problems in the Kalibaru watershed from the Sampean Baru River Area Water Resources Management Center in Bondowoso. The data such as the results of laboratory analysis of physical, chemical and microbiological properties in 3 (three) observation points of the Kalibaru watershed. The results of the analysis were processed using the regression method became a model for decrease in water quality as seen from the 3 parameters above and compared with the Republic of Indonesia Government Regulation No. 82 of 2001. Data analysis of the above parameters from January to December 2017 with the Polynomial equation of order 6. Research parameters include pH, BOD, PO4N, NO2N with MAXR method. The parameters of pH observation stasion in upstream, middle and downstream get result R Max respectively are 0,76; 0,60; 0,57. BOD parameter values respectively are 0,59: 0,42: 0,18. PO4P paramater values respectively are 0,52; 0,47; 0,48. NO2N paramater values respectively are 0,66; 0,71; 0,77. Fecal Coli parameter values respectively are 0,57; 0,85; 0,87.

1. Introduction

Some researches related to the mathematical model of changes in river water quality had been conducted, one of them was done [1] in the Cisadene watershed or Daerah Aliran Sungai (DAS) with Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and fecal coli parameters with the results in the form of changes in the quality level of BOD, COD, and Fecal coli that are caused by the population growth, so that it has implication for increasing industrial waste and domestic waste.

The condition of changes in water quality in the Cisadane watershed also occurs in the Kalibaru watershed, where the economic activities such as industrial, agricultural, plantation and fisheries along the Kalibaru watershed, from upstream, midstream and downstream are quite intensive with high population growth. This condition implies the entry of pollutants into the river body. Therefore, a

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mathematical model of changes in river water quality is very important to be carried out as an effort to predict the quality of water that can be used by the community along the watershed in accordance with its function.

The observation stations were done in upstream, midstream and downstream respectively in Kalibaru Manis Village of Kalibaru District, Karangharjo Village of Glenmore District and Karangdoro Village of Gambiran District, Banyuwangi Regency. The parameters observed were physical parameter (pH), chemical parameter (BOD, PO_4P, NO_2N) and microbiological parameter (Fecal coli), so that a mathematical model was obtained to predict a more comprehensive decrease in water quality.

2. Literature Review

Literature review that will be used for this research are

2.1. Water Pollution and Pollution Sources

Water pollution is the entry/inclusion of living things, energy and or other components into the river water from industrial activities, agriculture, plantations and fisheries which cause the quality of the river water decreases to a certain level so that the water cannot meet its intended function [2], where the pollution sources into the river water can be divided into domestic source and non-domestic source [3].

2.2. Criteria, Status, and Quality Standard of WaterStatus Air

Water quality is the desired concentration limit so that water has a quality that is worth to use in accordance with its function. Water quality standard is set by the government by including restrictions on the concentration of various water quality classifications according to their functions [4]. Criteria for water quality based on their class [5], are: (1) First class, intended as raw water for drinking water, and or other uses with water quality requirements that are the same as those uses; (2) Second class, is intended as a water recreation infrastructure/facility, freshwater fish cultivation, livestock, water for agriculture, and or other uses with the same water quality requirements as those uses; (3) Third class, intended as the cultivation of freshwater fish, livestock, agricultural water, and or other uses with the same water requirements as those uses; (4) Fourth class, intended as agricultural water, and or other uses with the same water quality requirements as those uses.

2.3. Regression Analysis

2.3.1. Definition of Regression

Regression is a correlation of two or more variables of observation values which can be interpreted in two forms [6] that are: (1) The position of the average population from the value of a variable, (2). If there is limited data available, regression is an adjustment of the function of the data.

2.3.2. Function of Regression

The function of the regression equation is as follows: (1) Description of the data, which is when the regression equation is still in the stage of data searching and benchmarking, (2) cause and effect relationship, (3) controlled experiment if there are factors that are difficult to control but can be expected to affect factor Y so that it functions as a regression analysis that is used as a comparative investigator and (4) Preparation of models and patterns of relationships of many variables X1, X2, X3, ..., Xk with variable Y, regression to find the most appropriate relationship or model with only involves a few of the variables X1, X2, X3, ..., Xk.

2.4. Regression Analysis Model

Regression analysis model for decrease in water quality in the Kalibaru watershed is explained by [7], including:

2.4.1. Linear

Is a straight line equation that can be written in the form: $Y = a + bX$.

2.4.2. Polynomial

The general form of a polynomial equation is: Y = anXn + an-1Xn-1 + ... + a1X + a0
Where: an, an-1, ..., a1, a0 are polynomial constants/coefficients; n is a non-negative integer; x is an independent variable that can be used to predict; and y is the dependent variable.

2.4.3. Exponential

Exponential function is formed as: f (X) = ax ...

Where: x is an independent variable that can be used to predict; a is a positive constant; and y is the dependent variable.

There are three types of exponential functions y = ax. If 0 <a <1, the exponential function goes down; if a = 1, the function is constant; and if a> 1, the function rises.

2.4.4. Logarithm

If a> 0 and a ≠ 1, the exponential function f (x) = ax is a function of decrease or increase, and therefore one-to-one. So it has an inverse function f-1, which is called a function of logarithms with principal number a and denoted by log, if we use the inverse function form:

log aX = y, ay = x

Where: x is an independent variable that can be used to predict; a is a positive constant; y is the dependent variable.

2.5. Adjusted R^2

Regression equation that has been obtained, can be used to estimate the equations generated by the data, and can be continued by assessing the good or bad suitability of the model with the data by evaluating the method of Relation Coefficient, Largest R^2. R^2 as the correlation coefficient or determinant coefficient (determination). The closer R^2 to number 1, the better the data match to the model [8].

3. Working Methodology

3.1. Research Location

This research was conducted in the Kalibaru Watershed with observation points in upstream, midstream and downstream respectively located in Kalibaru Manis Village of Kalibaru District, Karangharjo Village of Glenmore District and Karangdoro Village of Gambiran District, Banyuwangi Regency.

3.2. Tool and Material

The research tool used was Excel 2010 software. The materials used were: (1). physical parameter (pH), chemical parameter (BOD, PO4P, NO2N) and microbiological parameter (Fecal coli). Calculated Analytical Hierarchy Process (AHP).

3.3. Research Method

3.3.1. Research Approach Framework

The research approach framework was carried out by: (1) data collection to describe water quality problems in the Kalibaru watershed from the Sampean Baru River Area Water Resources Management Center in Bondowoso. The data such as the results of laboratory analysis of physical, chemical and microbiological properties in 3 (three) observation points of the Kalibaru watershed. The results of the analysis were processed using the regression method became a model for decrease in water quality as seen from the 3 parameters above and compared with the Republic of Indonesia Government Regulation No. 82 of 2001. The data from this research came from secondary water quality data in the Kalibaru Watershed from the Water Resources Management Unit of Bondowoso which measured the water quality [9].

3.3.2. Data Analysis Method

1. Water Quality Analysis

The water quality data of the Kalibaru watershed were analysis of physical, chemical and microbiological properties according to Government Regulation of Republic of Indonesia No. 82 of 2001 as shown in Table 1 [10].

2. Regression Analysis

The method used in analyzing the data of water quality in Kalibaru watershed was the 6th Polynomial Model regression analysis method; it was based on the MAXR concept of the 6th polynomial model that met the requirements. Regression analysis method was able to estimate the value of water quality in Kalibaru watershed at the observation station, although there was no measurement made at the station. Regression analysis by using Microsoft Office Excel 2010 and the produced regression analysis model could be analyzed in details [11].

Table 3.1 The Variable of Water Quality, Analysis and the Tools used.

No	Parameters	Unit	Quality I	Quality II	Quality III	Quality IV	Analytical Model
1	pH	-	6 s/d 9	5 s/d 9	5 s/d 9	5 s/d 9	potentiometer
2	BOD	mg/L	2	3	6	12	open reflux
5	PO4-P	mg/L	0.2	0.2	1	5	spectrometry
6	NO3-N	mg/L	10	10	20	20	spectrometry
Microbiology							
1	TotalColi	total/100ml	5000	5000	5000	5000	MPN method
2	Fecal Coliform		5000	5000	5000	5000	MPN method

4. Experiment and Result

4.1. Physical Characteristic

The result of monitoring the upstream, the midstream and the downstream respectively at observation stations was located in Kalibaru Manis Village of Kalibaru District, Karangharjo Village of Glenmore District and Karangdoro Village of Gambiran District, Banyuwangi Regency. It showed that the average pH data of 6.85; 6.95 and 6.85 were listed in Graph 1; 2 and 3. The graph changes in pH at 3 stations were drawn in Figure 4 and the average value of both observation and prediction was available on Figure 5.

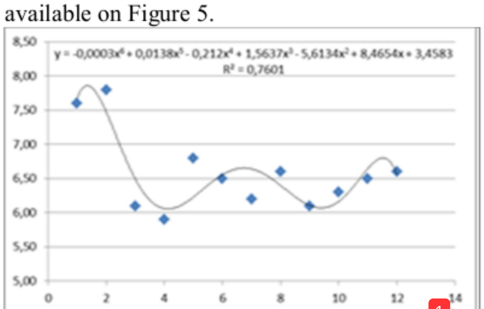

Figure 1. The Distribution Pattern of PH in the Period of January - December 2017 at the upstream observation station.

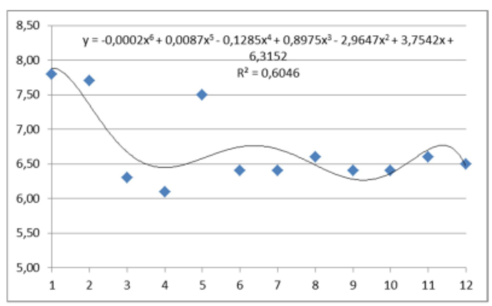

Figure 2. The Distribution Pattern of PH the Period of January - December 2017 at the midstream observation station.

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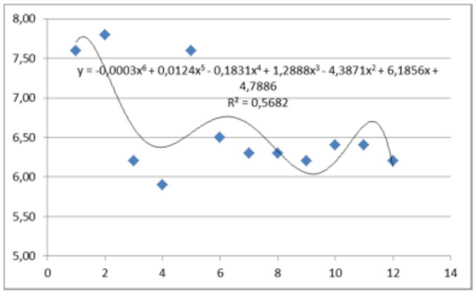

Figure 3. The Distribution Pattern of PH January - December 2017 Periodat the downstream observation.

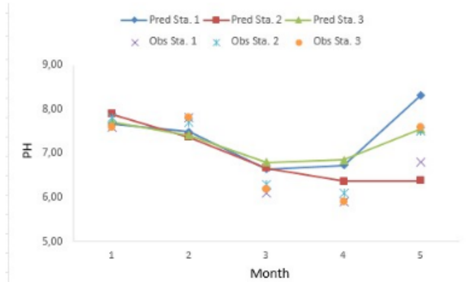

Figure 4. The Distribution Pattern of PH Observation and Prediction in the period of January - December 2017.

If it was compared to the data from Government Regulation of The Republic of Indonesia No. 82/2001, the pH value was still in the acceptable range, so that water quality I, II, III and IV reached 0 as their value. This means that the pH did not give any contributions to the contamination of Kalibaru watershed.

The mathematical model of pH value was based on the 6th polynomial equation, which were $y = -0{,}00030\ x^6 + 0{,}014\ x^5 - 0{,}21x^4 + 1{,}56\ x^3 - 5{,}61x^2 + 8{,}46\ x + 3{,}46$ with $R^2 = 0{,}76$; $y = -0{,}00020\ x^6 + 0{,}0087\ x^5 - 0{,}13\ x^4 + 0{,}90\ x^3 - 2{,}96\ x^2 + 3{,}75\ x + 6{,}32$ with $R^2 = 0{,}60$; $y = -0{,}00030\ x^6 + 0{,}012\ x^5 - 0{,}18\ x^4 + 1{,}29\ x^3 - 4{,}39\ x^2 + 6{,}19\ x + 4{,}79$ with $R^2 = 0{,}57$.

The changes of pH value in the upstream, the midstream and the downstream stations in accordance to MAXR method were 0.76; 0.60 and 0.57. This showed that Kalibaru watershed had no significant change in pH and was still in required limitation.

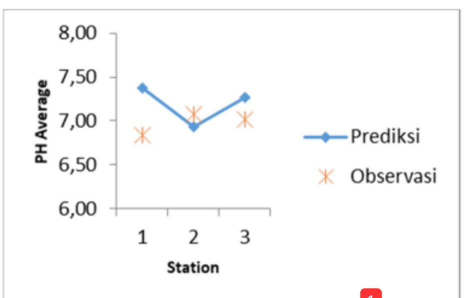

Figure 5. The Average Value of PH observation and prediction in the period of January - December 2017.

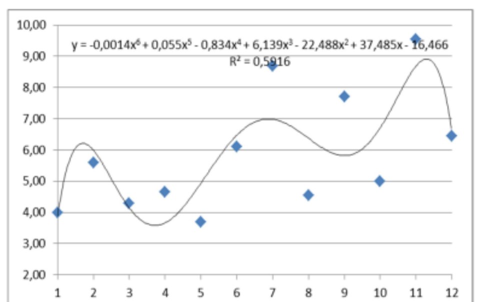

Figure 6. The Distribution Pattern of BOD mg/L in the Period of January - December 2017 at the upstream observation station.

The prediction result by using mathematical model in which PH value was obtained from the upstream (station 1), the midstream (station 2) and the downstream (station 3) were 7.37; 6.93 and 7.27. As they were compared to the average of PH value, the observation results which had consecutive values were 6.85; 6.95 and 6.85. Thus, it was clear that the average value of PH prediction was not as different as the average value of PH observation. The difference of the average value of PH prediction and observation obtained from the upstream, the midstream and the downstream were 0.53; 0.15 and 0.25. This mathematical model was capable to determine the average value of PH prediction since the difference between prediction and observation was less than 10% which was the limit/threshold value of mathematical model's feasibility to be used as a prediction.

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4.2. Chemical Characteristic

4.2.1. BOD (mg/L)

The chemical characteristic that was used as the parameters covered: (1) BOD, (2) PO4P, and (3) NO2N. BOD contamination in the upstream, the midstream and the downstream in the observation stations showed the average value of 6.20 mg/L; 7.23 mg/L; 6,50 mg/L, as the requirements of the water quality III and IV were fulfilled according to the Government Regulation of The Republic of Indonesia No. 82/2001. BOD value in 3 observation stations was listed in the following Figure 6, 7 and 8. These data showed that BOD value from the upstream to midstream had an increase, whereas from the midstream to the downstream had a decrease. The increased BOD value was due to the existence of pollutant entering the river flow, meanwhile the decreased BOD value was caused by a decrease of pollutant in river flow.

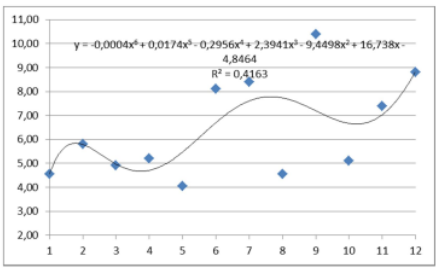

Figure 7. The Distribution Pattern of BOD mg/L in the Period of January - December 2017 at the midstream observation station.

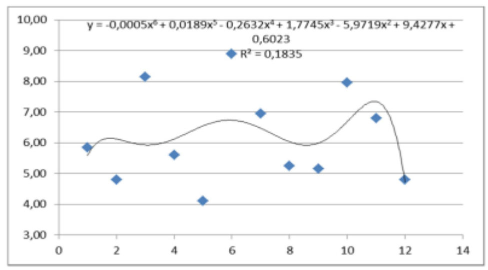

Figure 8. The Distribution Pattern of BOD mg/L in January - December 2017 Period at the downstream observation station.

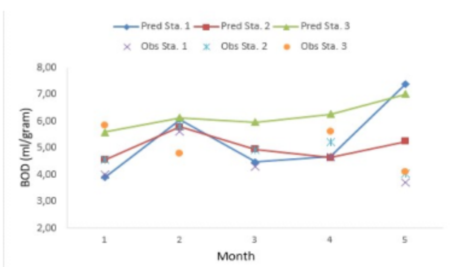

Figure 9. The Distribution Pattern of BOD Observation and Prediction from the upstream to the downstream.

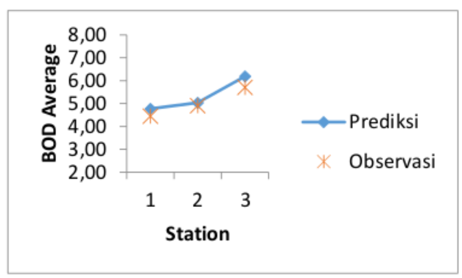

Figure 10. The Average Value of BOD Observation and Prediction from the Upstream to The downstream.

The mathematical model of BOD value adapted the 6th polynomial equation, $y = -0.0014\ x^6 + 0.055\ x^5 - 0.83\ x^4 + 6.14\ x^3 - 22.49\ x^2 + 37.49\ x - 16.47$ with $R^2 = 0.59$; $y = -0{,}00040\ x^6 + 0{,}017\ x^5 - 0{,}30\ x^4 + 2{,}39\ x^3 - 9{,}45\ x^2 + 16{,}74\ x - 4{,}85$ with $R^2 = 0{,}42$; $y = -0{,}00050\ x^6 + 0{,}019\ x^5 - 0{,}26\ x^4 + 1{,}77\ x^3 - 5{,}97\ x^2 + 9{,}43\ x + 0{,}60$ with $R^2 = 0{,}18$. The BOD value from the result of calculation by using mathematical model can be seen in Figure 9 and the average distribution value of BOD can be seen in Figure 10.

The changes in BOD value from the upstream, the midstream and the downstream stations based on MAXR method were 0.59; 0.42 and 0.18. The prediction result by using the obtained mathematical model, the average BOD value from the upstream (station 1), the midstream (station 2) and the downstream (station 3) were as much as 4.77; 5.03 and 6.19. As it was compared to the average BOD value of the observation result which reached the value of 6.20 mg/L; 7.23 mg/L; 6.50 mg/L, it could be seen that BOD average value of the prediction did not differ from the BOD average value of observation. The difference of BOD average value of both prediction and observation obtained in the upstream, the midstream and the downstream were 1.43; 2.2 and 0.31. This mathematical model was capable to be used as the determination of the average BOD value of prediction in the downstream station since the difference between the prediction and observation was less than 10% which was the limit/threshold value of mathematical model's feasibility to be used as a prediction.

4.2.2. PO_4P (mg/L)

The mean values of PO_4P (mg/L) in the upstream, the midstream and the downstream observation stations were 0.24 mg/L; 0,25 mg/L; 0.21 mg/L. The graph of PO_4P pollution reduction level was shown in Figure 11; 12 and 13. When compared to the water quality I along with the requirement of PO_4P content <0.2 mg/L, Kalibaru watershed could be used as the raw water quality I, II, III and IV. Phosphate values were constantly changing as it was because of the various pollution received by water and its coverage area. Phosphate contamination was caused by the pollution due to the anthropogenic activity, industry and livestock. The use of detergents, shampoo and soap from anthropogenic activities and industrial waste which were not neutralized caused foaming water and decreased the oxygen absorption. Based on the observations in the field, many people used the river for public bathing, washing facilities and latrines (MCK).

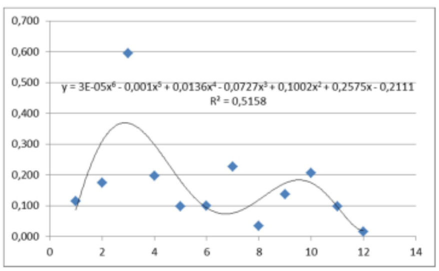

Figure 11. The Distribution Pattern of PO_4P mg /L in January - December 2017 period at the upstream observation station.

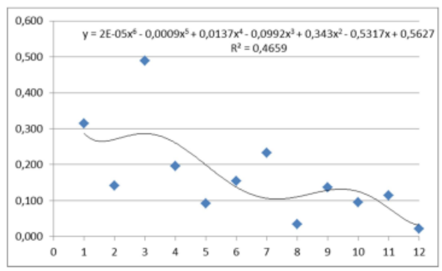

Figure 12. The Distribution Pattern of PO_4P mg/L in January - December 2017 period at the middle observation station.

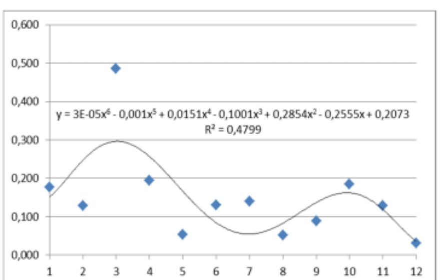

Figure 13. The Distribution Pattern of PO_4P mg/L in January - December 2017 Period at the downstream observation station.

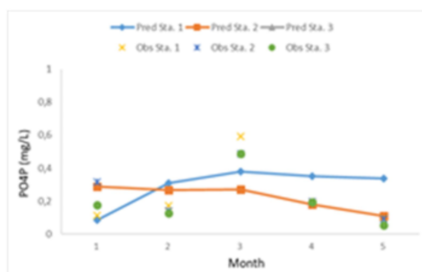

Figure 14. The Distribution Pattern of PO_4P Observation and Prediction from the upstream to the downstream.

Mathematical model of PO_4P pollution reduction in the upstream, the midstream and the downstream observation stations were $y = 3E\text{-}05\ x^6 - 0{,}0010\ x^5 + 0{,}014\ x^4 - 0{,}073\ x^3 + 0{,}10\ x^2 + 0{,}26\ x - 0{,}21$ with $R^2 = 0{,}52$; $y = 2E\text{-}05\ x^6 - 0{,}00090\ x^5 + 0{,}014\ x^4 - 0{,}099\ x^3 + 0{,}34\ x^2 - 0{,}53\ x + 0{,}56$ with $R^2 = 0{,}47$; $y = 3E\text{-}05\ x^6 - 0{,}0010\ x^5 + 0{,}015\ x^4 - 0{,}10\ x^3 + 0{,}29\ x^2 - 0{,}26\ x + 0{,}21$ with $R^2 = 0{,}48$. The value of PO_4P from the result of calculation by using mathematical model can be seen in Figure 14 and the average distribution value of PO_4P can be seen in Figure 15.

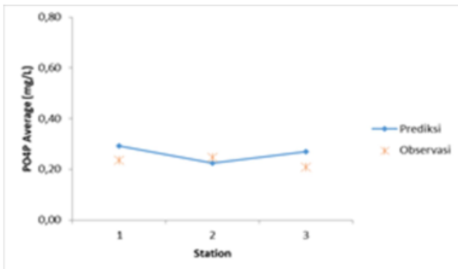

Figure 15. The Average value of PO_4P Observation and Prediction from the upstream to the downstream.

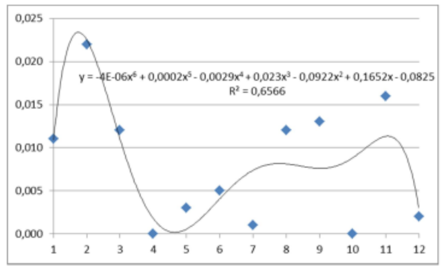

Figure 16. The pattern of distribution of NO_2N mg/L for the period of January - December 2017 at the upstream observation station.

The changes in PO_4P values from upstream, midstream and downstream stations based on the MAXR method were obtained 0.52; 0.47 and 0.48. The prediction results using mathematical model had been obtained the PO_4P average values from upstream (station 1), midstream (station 2) and downstream (station 3) respectively 0.29; 0.22 and 0.27. When compared to the PO_4P average value of the observation which had values of 0.24; 0.25 and 0.21, it can be seen that the average value of PO_4P prediction was not much different from the PO_4P average value of observation. The difference from the PO_4P average value of the prediction and observation obtained from upstream, midstream and downstream were 0.06; 0.02 and 0.06. This mathematical model could be seen in determining the prediction of average value of PO_4P because the difference between prediction and observation was less than 10% which was the threshold value of the mathematical model feasibility to be used as the determination of predictive values.

4.2.3. NO_2N (mg/L)

The average value of NO_2N (mg/L) pollution in upstream, midstream and downstream observation stations were 0.01 mg/L; 0.01 mg/L and 0.02 mg/L with a graph of NO_2N pollution reduction (mg/L) shown in Figure 16; 17 and 18. This value was still under the second quality water quality threshold required by the East Java Provincial Regulation No. 2 of 2008 of 0.06 mg/L. Sources of nitrite came from industrial and domestic waste. Natural water contained nitrite 0.001 mg/lt and should not exceed 0.06 mg/L.

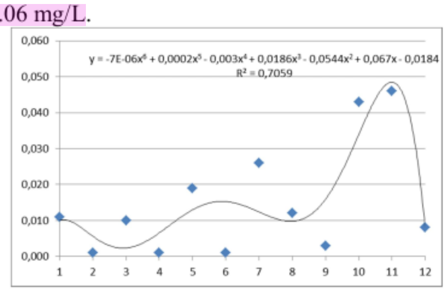

Figure 17. The distribution pattern of NO_2N mg/L for the period of January - December 2017 at the midstream observation station.

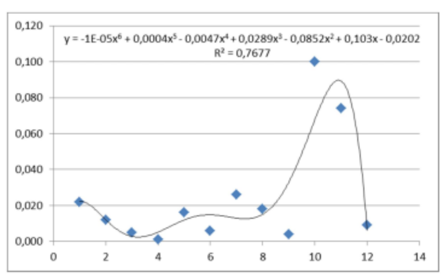

Figure 18. The distribution pattern of NO_2N mg/L for the period of January - December 2017 at the downstream observation station.

The mathematical models for NO_2N pollution reduction in upstream, midstream and downstream observation stations were $y = -4E\text{-}06\ x^6 + 0{,}00020\ x^5 - 0{,}0029\ x^4 + 0{,}023\ x^3 - 0{,}092\ x^2 + 0{,}17\ x - 0{,}083$ with $R^2 = 0{,}66$; $y = -7E\text{-}06\ x^6 + 0{,}00020\ x^5 - 0{,}0030\ x^4 + 0{,}019\ x^3 - 0{,}054\ x^2 + 0{,}067\ x - 0{,}018$ with $R^2 = 0{,}71$; $y = -1E\text{-}05\ x^6 + 0{,}00040\ x^5 - 0{,}0047\ x^4 + 0{,}029\ x^3 - 0{,}085\ x^2 + 0{,}10\ x - 0{,}020$ with $R^2 = 0{,}77$. The NO_2N value from the calculation results using a mathematical model can be seen in Figure 19 and the average distribution value of NO_2N can be seen in Figure 20.

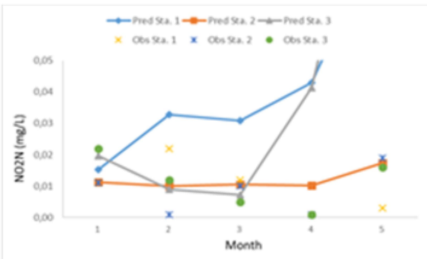

Figure 19. The pattern of NO_2N Observation and Prediction spread from upstream to downstream.

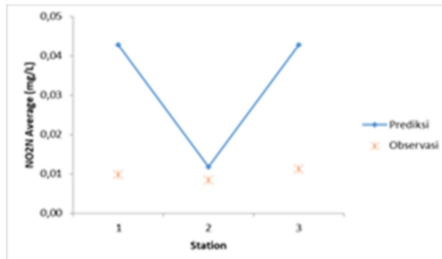

Figure 20. The average value of NO_2N Observation and Prediction from upstream to downstream.

Changes in NO_2N values from upstream, midstream and downstream stations based on the MAXR method were obtained 0.66; 0.71 and 0.77. The results of the prediction using mathematical models had been obtained the average NO_2N values from upstream (station 1), midstream (station 2) and downstream (station 3) respectively 0.04; 0.01 and 0.04. When compared to the average NO_2N value of the observation which had values of 0.01; 0.01 and 0.02 it could be seen if the average NO_2N value of the prediction was not much different from the NO_2N average value of observation. The difference between the NO_2N value of the average prediction and observation obtained from upstream, midstream and downstream were 0.03; 0 and 0.03. This mathematical model could be seen in determining the NO_2N average value of the prediction because the difference between prediction and observation was less than 10% which was the threshold value of the mathematical model feasibility to be used as a prediction value.

4.3. Microbiological Characteristic

4.3.1. Fecal coli (population/100 mL)

The average value of Fecal coli (population/100 mL) in upstream, midstream and downstream observation stations respectively were 29.8 population/100 mL; 22.4 population/100 mL and 18.8 population/100 mL. . The total amount of coliform was still under the criteria for class II river water quality of 5,000 mg/L. Fecal coli pollution graph is shown in Figure 21; 22 and 23.

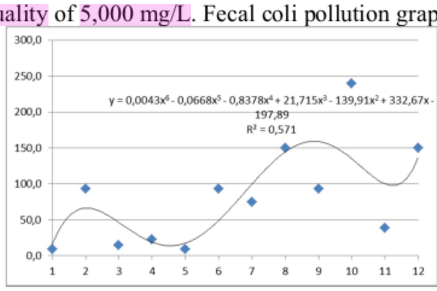

Figure 21. The pattern of the spread of Fecal coli for the period of January - December 2017 at the upstream observation station.

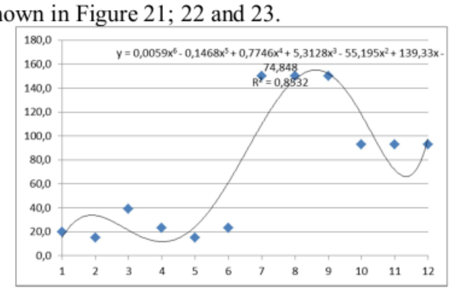

Figure 22. The pattern of distribution of Fecal coli for the period of January - December 2017 at the middle observation station.

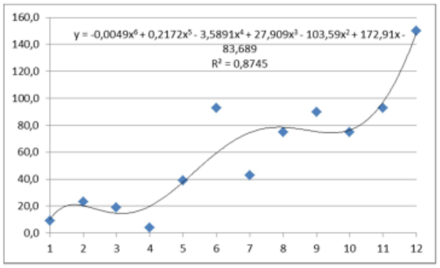

Figure 23. The pattern of distribution of Fecal coli for the period of January - December 2017 at the middle observation station.

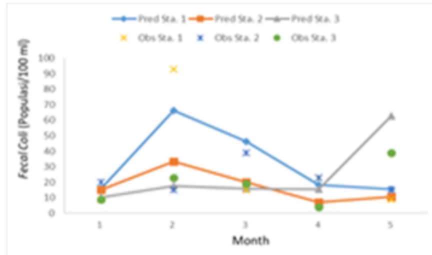

Figure 24. The pattern of spread of Fecal coli Observation and Prediction from upstream to downstream.

The mathematical model of Fecal coli decrease in upstream, midstream and downstream stations respectively were $y = 0.0043\ x^6 - 0.067\ x^5 - 0.84\ x^4 + 21.72\ x^3 - 139{,}91x^2 + 332{,}67\ x - 197{,}89$ with $R^2 = 0{,}57$; $y = 0.0059\ x^6 - 0.15\ x^5 + 0{,}77\ x^4 + 5{,}31\ x^3 - 55{,}19\ x^2 + 139{,}33\ x - 74{,}85$ with $R^2 = 0{,}85$; $y = -0.0049\ x^6 + 0.22\ x^5 - 3.59\ x^4 + 27.91\ x^3 - 103{,}59\ x^2 + 172{,}91\ x - 83{,}69$ with $R^2 = 0{,}87$. Fecal coli values from the calculation using mathematical model can be seen in Figure 24 and the average distribution of Fecal coli can be seen in Figure 25.

The changes in the Fecal coli value from upstream, midstream and downstream stations based on the MAXR method were 0.57; 0.85 and 0.87. The prediction results using the mathematical model had been obtained the Fecal coli average values from upstream (station 1), midstream (station 2) and downstream (station 3) respectively 32.29; 17,22 and 24,34. When compared to the average of Fecal coli, the results of observation which had a consecutive values of 29.8; 22.4 and 18.8, it could be seen that the Fecal coli average value of prediction was not much different from the Fecal coli average value of observation. The difference between the Fecal coli average value of the prediction and observation obtained from upstream, midstream and downstream were 2.59; 5.17 and 5.54. This mathematical model could be seen to be used in determining the Fecal coli average value of the predicted prediction at the upstream station that had difference in value between the smallest prediction and observation.

4.3.2 Total Coliform (population/100 mL)

Water quality can be determained from total coliform used the bacteria indicator. Coliform was founded a lot in warm-blooded animal's feces but it could also find in the water, soil, and vegetation environments. The measurement result showed that the coliform concentration in Kalibaru watershed was about 25-240 population /100ml. The distribution pattern of coliform value could be seen in Figure 17 and the coliform prediction and observation values could be seen in Figure 18. The value of total coliform was in water quality threshold.

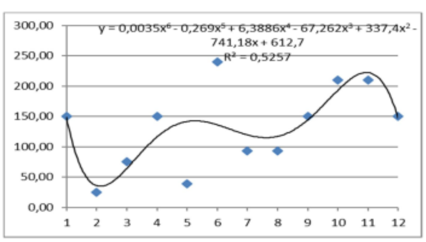

Figure 25. Coliform Distribution of Kalibaru watershed in January – December 2017 Period.

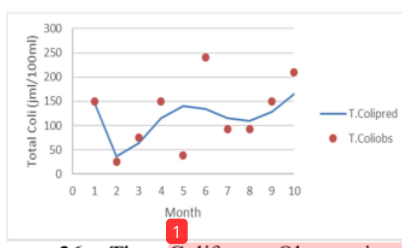

Figure 26. The Coliform Observation and Prediction in January December 2017 Period.

The change total coliform based on the MAXR method was 0.5257 and the gotten mathematical model was y = 0,0035x6 - 0,269x5 + 6,3886x4 - 67,262x3 + 337,4x2 - 741,18x + 612,7. The average total coliform prediction value was 116.3 population/100ml and the total coliform observation value was 113.17 population/100ml

5. Conclusion

From the research results on mathematical model to obtain the prediction value of the water quality of the Kalibaru watershed, it was concluded: The parameters of pH observation stasion in upstream, middle and downstream get result R Max respectively are 0,76; 0,60; 0,57. BOD parameter values respectively are 0,59: 0,42: 0,18. PO4P paramater values respectively are 0,52; 0,47; 0,48. NO2N paramater values respectively are 0,66; 0,71; 0,77. Fecal Coli parameter values respectively are 0,57; 0,85; 0,87.

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References

[1] Vollmer D, Costa D, Lin ES, Ninsalam Y, Shaad K, Prescott MF, et al 2015 JAWRA *Journal of the American Water Resources Association*.;**51(3)**:672-88.
[2] Regulation, G., 1990 concerning: Water Pollution Control. State Gazette of the Republic of Indonesia.
[3] Corominas L, Foley J, Guest J, Hospido A, Larsen H, Morera S, et al 2013 t. *Water research* ;**47(15):**5480-92.
[4] Permatasari PA, Setiawan Y, Khairiah RN, Effendi H, editors 2017 IOP Conference Series: Earth and Environmental Science: IOP Publishing.
[5] G. R. O. Q. And W. A. C. Control 2002 Water Quality And Water Pollution Control President Of The Republic Of Indonesia.
[6] Willer H, Lernoud J 2016: Research Institute of Organic Agriculture FiBL and IFOAM Organics International.
[7] Grover, C. and J. Stewart 2002 The work connection: The role of social security in British economic regulation. Palgrave Basingstoke.
[8] Sembiring, H., W. Raun, G. Johnson and R. Boman 1995 *Soil science* **159**, 81-89.
[9] Bagal MV, Gogate PR 2014 *Ultrasonics Sonochemistry* ;**21(1)**:1-14.
[10] Walukow A. F 2010 *Biological News*, vol. **10**, pp. 277 – 281.
[11] K. L. Taufik 2003 Faculty of Fisheries and Marine Science, IPB, Bogor.

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